119 JUL 21 1933

Volume 19 July, 1933 *Number 7*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Construction Machinery

Protection by Effective Lubrication

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO

LUBRICATION RECOMMENDATIONS FOR CONSTRUCTION MACHINERY

Power Shovels, Draglines, Trenching and Hauling Machines, Concrete Mixers, Concrete Finishers, Finishing Machines

●

POWER PLANT

Gasoline Engines	
Temperatures Above 75° F.	TEXACO MOTOR OIL H OR TEXACO BUS OIL XX
Temperatures From 40° to 75° F.	TEXACO MOTOR OIL G OR TEXACO BUS OIL X
Temperatures Below 40° F.	TEXACO MOTOR OIL F OR TEXACO MOTOR OIL E
Diesel Engines	TEXACO URSA OIL
Steam Engines	TEXACO PINNACLE CYLINDER OIL
Electric Motor Drives	
Grease Lubricated Bearings	TEXACO MARFAK GREASE No. 2 OR TEXACO STAR GREASE No. 1
Ring Oiled Bearings	TEXACO CANOPUS OIL, TEXACO CETUS OIL OR TEXACO ALEPH OIL
Air Compressors	TEXACO ALCAID OIL OR TEXACO ALGOL OIL

MISCELLANEOUS GENERAL LUBRICATION

Gears and Chains	
Enclosed	TEXACO 569 GEAR OIL W OR TEXACO THUBAN COMPOUND K OR S
Exposed	TEXACO CRATER COMPOUND No. 1 OR No. 2
Wire Rope and Cables	TEXACO CRATER COMPOUND No. 0 OR No. 1
Bearings—Grease Lubricated	
Normal Temperatures	TEXACO CUP GREASE No. 1 OR No. 3
Temperatures Below 20° F.	TEXACO STAR GREASE No. 1
Bearings	
Oil Lubricated	SAME OIL AS USED IN POWER PLANT

THE TEXAS COMPANY

Texaco Petroleum Products

135 East 42nd Street, New York City

Atlanta Boston Butte Chicago Dallas Denver Houston Los Angeles Minneapolis New Orleans New York Norfolk Seattle

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by
The Texas Company, 135 East 42nd Street, New York City
Copyright 1933 by The Texas Company
Vol. XIX July, 1933 No. 7

Change of Address: In reporting change of address kindly give both old and new addresses.
"While the contents of LUBRICATION are copyrighted, other publications will be granted permission to reprint on request, provided article is quoted exactly and credit given to THE TEXAS COMPANY."

Construction Machinery

Protection by Effective Lubrication

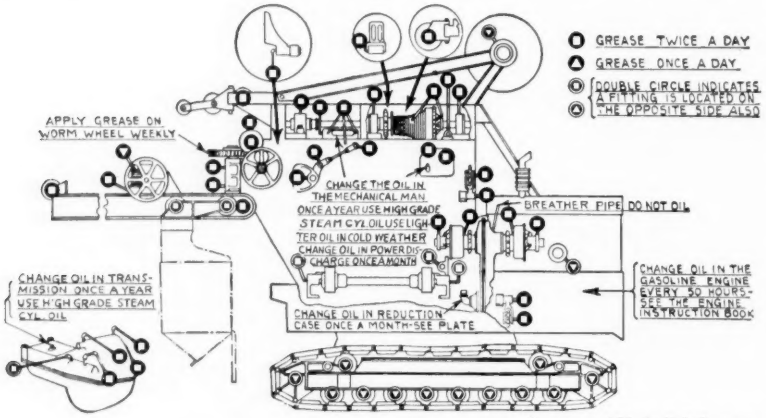
IN the rehabilitation of industry a wide variety of new equipment must be put into service to replace those units which through obsolescence, wear and tear, and economy in maintenance, have become incapable of meeting expected production demands. This applies particularly to construction machinery where exposure to the weather presents a distinctive problem in maintenance and protection.

Construction engineering may be broadly divided into two parts, according to the nature of the work to be done, i.e., excavating and erecting. Both involve materials handling largely in bulk form. In excavating work air driven rock drills and breakers, with air compressors and power shovels of Diesel, steam, or gasoline type, constitute the essential equipment. In subsequent erection work where actual construction takes place, concrete mixers, air driven riveters, reamers and hoists of electric or air driven type are used. Lubrication of the majority of such machinery should be studied with due regard for the exposed conditions under which operations must be carried out, in the realization that contamination of lubricants with water or abrasive foreign matter may often occur, accompanied by a comparatively wide range of temperatures in many cases. Protection of lubricants under such conditions is highly essential, for it is imperative that they be capable of functioning effectively regardless of weather and temperature fluctuation. The probability of water being present in sufficient quantity on the average construction job to reach to certain of the moving parts of some machines, requires full appreciation of the detrimental effects which may result. If present in any appreciable amount water will tend to wash off certain types of lubricants should it gain access to these parts. For water conditions care should be taken to select products which have been so refined as to render them water-resistant.

INTERNAL COMBUSTION ENGINES

Study of power plant requirements in construction engineering with respect to the internal combustion engine has led to the development of a decidedly compact and extremely economical arrangement of the essential equipment. It is important to remember, however, that the internal combustion engine of either the gasoline or Diesel type is of more intricate construction than the average steam engine used for such service. As a result, it requires more care and attention, especially in maintenance and lubrication. Very often the cause of break-down in an internal combustion engine is due to improper lubrication. For this reason the designers have developed means of lubrication as completely automatic as practicable. The systems which have been found to meet this requirement involve full pressure or a combination of splash and force-feed, the oil being handled by a gear pump, driven by the main shaft of the engine, or by

means of a mechanical force feed lubricator. The latter, installed externally, delivers fresh oil to the cylinders drop by drop. It can also be piped to the main bearings. Such a lubricator overcomes the objection of possible crankcase dilution by furnishing a supply of fresh oil of the right viscosity constantly to each bearing and cylinder. This method of lubrication is very similar to that so commonly employed on many types of stationary Diesel engines. The oil flow is accurately controlled in its intensity, as well as in its starting and stopping, since the lubricator pumps are operated by connection to some moving part of the engine.


GREASE TWICE A DAY
GREASE ONCE A DAY
DOUBLE CIRCLE INDICATES A FITTING IS LOCATED ON THE OPPOSITE SIDE ALSO
APPLY GREASE ON WORM WHEEL WEEKLY
CHANGE THE OIL IN THE MECHANICAL MAN ONCE A YEAR USE HIGH GRADE STEAM CYL OIL USE LIGHTER OIL IN COLD WEATHER
CHANGE OIL IN POWER DISCHARGE ONCE A MONTH
BREATHER PIPE DO NOT OIL
CHANGE OIL IN TRANSMISSION ONCE A YEAR USE HIGH GRADE STEAM CYL OIL
CHANGE OIL IN REDUCTION CASE ONCE A MONTH-SEE PLATE
CHANGE OIL IN THE GASOLINE ENGINE EVERY 50 HOURS-SEE THE ENGINE INSTRUCTION BOOK

Courtesy of Chain Belt Company

Fig. 1—Showing lubrication diagram of the Rex Road Maker. Note that parts requiring lubrication, with frequency of same, are indicated.

The efficiency of such an engine is not entirely dependent upon the method of lubrication, however, for there are other factors, such as the fuel and its manner of combustion, the grade of lubricants used, the extent to which proper cooling is brought about, which may, individually or collectively, affect power development to a marked extent.

Gasoline Engine Drives

The comparatively intensive duty which prevails in the operation of the average construction machine necessitates thorough understanding of the extremely exacting requirements which are imposed upon both oil and the lubricating system. In fact, certain of these are so important that it is well to discuss them in more detail. A better realization of their importance will enable the operator to understand the matter of lubrication more intelligently, and appreciate its relation to efficient and economical operation during the life of the machine.

In this regard, an oil for such service must possess maximum lubricating ability. This will be assured by its heat resisting characteristics, seal-forming properties, low pour test to insure ready flow on cold starting, and sufficient viscosity to enable the maintenance of an adequate lubricating film with the least amount of internal friction.

The proof of lubricating ability will be the extent to which an oil will be able to develop and maintain a lubricating film between moving parts. The higher this property, the greater will be the insurance against development of wear, burnt out bearings, or scored cylinders.

Heat resisting ability is a most important factor, for this will be an indication of its resistance to decomposition and the possible development of extensive carbonaceous residue.

Seal forming ability will involve the extent to which the oil will prevent loss of compression, blow-by of combustible gases, or pumping of lubricating oil past the piston rings to lead to carbon formation.

The pour test requires consideration wherever cold weather operation will prevail, for it will indicate how the oil will act under cold operating conditions. Obviously the lower the pour test, or the temperature of relative congealment, the more dependable will be the lubricating oil, for it will be assurance of sufficient fluidity to enable the oil to pass readily through the lubricating system and reach the bearings the instant the engine is started.

Viscosity, in turn, requires consideration from the viewpoint of the extent to which the oil will resist being squeezed out from between any of the wearing parts where pressures may be comparatively high. Viscosity is intimately related to lubricating ability.

Diesel Engine Requirements

The Diesel engine has also been successfully applied to power shovel service. In its operation successful lubrication will be dependent upon the use of highly refined oil, and the application or delivery of same in sufficient, though never excessive amounts, to the cylinders and bearings by means of a properly designed oiling system.

Refinement insures of certain basic characteristics which will enable the oil to serve both cylinders and bearings successfully. In effect, it enables the oil:

1. To withstand the usual stresses and strains of intensive service. This requires

careful fractionation and removal of the lighter components, so that the resultant oil will not be so volatile as to require an undue quantity to maintain a suitable lubricating film, especially on the cylinder walls.

2. To show as low an emulsification tendency as practicable should there be contact with water at any stage of operation.
3. To possess sufficient viscosity or body to maintain a lubricating film of suitable thickness between the wearing surfaces, under the prevailing temperatures of operation. Yet it should never be so heavy or viscous at these temperatures as to give rise to abnormal internal friction within itself, for this might lead to excessive bearing temperatures.
4. To be sufficiently adhesive to resist being squeezed out from between the wearing surfaces when subjected to operating pressures.
5. To resist congealment at any of the lower temperatures to which it might be subjected during storage or operation.
6. To spread readily over the surfaces of the cylinder walls and not remain in streaks or blotches; otherwise suitable sealing of the pistons might be impaired.
7. To show as little carbon forming tendency as possible, inasmuch as the decomposition which will occur when the oil is exposed to the intensive heat of combustion will, in the case of many oils, develop a large amount of objectionable carbonaceous residuum.

Cylinder Lubrication

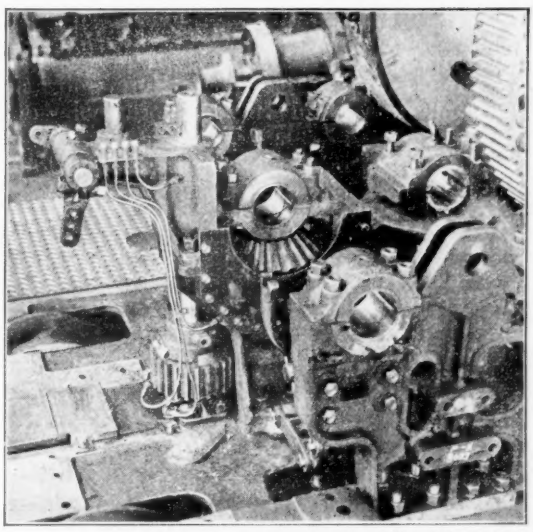
Development of wear in Diesel cylinders is usually the result of impaired lubrication. Cylinder liner wear may result in loss of compression, especially if the piston rings do not function properly. This will lead to inability to carry full load. Wear can be minimized by use of proper lubricants as well as dependable means of application. On the other hand, we should not overlook the fact that lubrication of Diesel engine cylinders will also be influenced to a certain extent by the grade of the fuel and the completeness of combustion.

Positive and uniform lubrication is excellent insurance against sticking of rings and loss of compression. It also protects the wrist pins. These parts on certain engines will be subjected to relatively high temperatures, with but little opportunity for radiation of heat.

Bearing Lubrication

Where Diesel engine bearings have been properly installed and correctly aligned, comparatively little wear will occur, for bearings, by virtue of their design and nature of operation, in general, lend themselves to a more effective development of perfect lubrication as a result of more complete separation of the wearing members by a continuous oil film. The power shovel Diesel is no exception to this rule. As adapted to present day highway construction machinery, it is so designed as to be effectively lubricated by the same oil as used for cylinders and bearings. There is considerable advantage in using an engine of this type, for it eliminates the necessity of stocking more than one grade of oil for the power plant. In many localities the carrying of supplies must be reduced as far as possible. Reduction in the number of lubricants required is therefore an advantage.

In warm weather a somewhat heavier oil should be used, just as in automobile service, in order to insure more positive maintenance of piston ring seal and dependable lubrication of the bearings. Whatever the grade of oil used, care should be taken to choose a product with a low carbon residue content, and for cold weather service, as low a pour test as possible. A highly refined, straight mineral product can be depended upon to give positive and effective lubrication and reduce the cost of operation to a minimum. If manufactured from selected crudes it will also show a sufficiently low carbon residue content to insure against trouble.



Courtesy of Harnischfeger Corp.

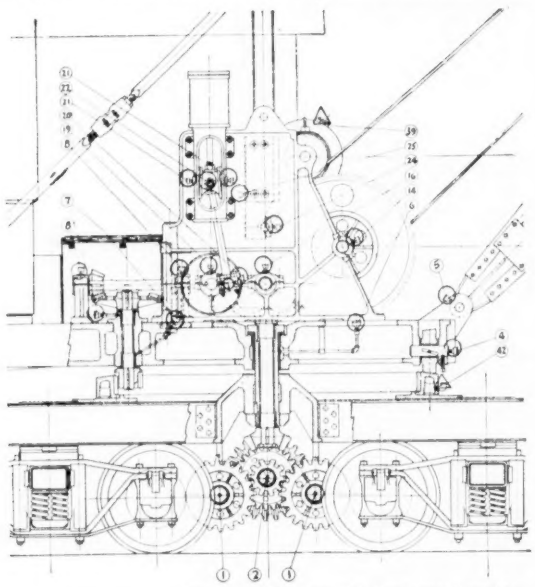
Fig. 2—Showing location of centralized lubrication nipples and leads to boom hoist worm shaft and intermediate swing shaft on the Harnischfeger Model 700 Excavator.

ELECTRIC MOTORS

The electric motor is adaptable to power shovel operation wherever power resources are available, although it is not as extensively used in the operation of highway construction machinery as the internal combustion engine,

or steam engine. Its practicability, however, demands consideration from a lubrication point of view.

Normally bearings alone will be involved, although the perfection of the geared motor may lead to some interesting installations with



Courtesy of The Browning Crane and Shovel Co.

Fig. 3—Showing sectional view of the working elements of a Browning crane. Parts indicated by circles are designed for grease lubrication, using a product capable of handling in compression grease cups. Parts indicated by triangles should be oiled weekly. Manufacturer recommends cylinder oil for clutches, machine oil for bearings, car oil for journal boxes and a highly refined protective lubricant for gears and wire rope.

the extension of our public works program. Lubrication must be positive and dependable, for any failure may lead to the possibility of the rotor coming in contact with the pole pieces, to cause burn-outs and shutdown of the machine. The electric motor is, perhaps, the most delicate mechanism involved in construction equipment. Frequently, however, it is given no more consideration than the gears and wire ropes; although these latter, by virtue of their comparatively heavy construction, and the nature of their lubrication, are far more capable of standing the duty imposed by temperature fluctuation, dust, dirt, water, or other contaminating foreign matter. Such conditions will impose a severe strain on motor bearings, by virtue of their design and construction, and the normally limited capacity of their lubricating systems.

Electric motors, as designed for power shovel service may be equipped with ring oiled bearings, or with anti-friction bearings of the ball or roller type. Where the ring oiler is employed oil must always be used as the lubricant. Normally, a straight mineral, highly refined product of from 175 to 300 seconds Saybolt at 100 degrees Fahr., will suffice.

The necessity for low pour test is obvious, especially where the machine is to be started and operated at comparatively low temperatures, since the average well aerated ring oiled bearing will not develop much heat. As a result, every care must be observed in the initial selection of the oil, to insure against congealment or sluggish flow. Otherwise, damage to the bearings might occur, due to failure of the oil to follow the rings.

Anti-friction bearings, on the other hand, can be lubricated either with oil or grease, according to the design of the bearing. As a general rule, oil is preferred where the bearing is capable of retaining the oil supply without leakage. Greases, on the other hand, furnish better seals against the entry of dust, dirt and moisture. For such service, resistance to moisture and oxidation is an important factor.

Other characteristics which a grease should possess when it is to be used for anti-friction bearing service involve:

1. Minimum tendency to separate in storage or during service in the bearing. With a properly prepared grease this should not occur even under moderate heating.
2. Maximum resistance to hardening or decomposition. This would lead to development of a residue of soap within the bearing, and soap has a comparatively low lubricating value.
3. There should also be no constituent contained in a grease which might lead to corrosion, pitting, or rusting of the bearing elements, nor should there be any component which might cause the lubricating film to become sticky or the grease to gum. This would cause the balls or rollers to stick in the raceways.

The above properties are contingent upon the grade and quality of the oil and soap used in manufacture, also the method of preparation. They are assured by the integrity of the manufacturer. From a mechanical viewpoint, however, the consistency or body will be of chief interest. Frequently a comparatively light product will best meet the requirements, especially if it contains an oil of sufficiently low pour test. On the other hand, there are certain grades of heavier greases which, by virtue of their lubricating ability will serve the purpose equally well, and with but a minimum tendency to channel in the housings.

STEAM CYLINDERS

In determination of the lubrication requirements of steam cylinders, consideration must be given to the existing operating conditions. These include steam pressure, location of cylinder oil inlet, type of lubricator, and moisture content of the steam. In average power

shovel service steam pressures will range in the neighborhood of 150 pounds pressure; normally it will have quite an extensive moisture content, even though it is taken from the highest part of the boiler. Furthermore, line condensation will be high between the boiler and engines, with a corresponding decrease in pressure, due to the fact that steam pipes are often not completely covered, and the engines are frequently subject to intermittent operation. This will lead to a considerable accumulation of water above the throttle valves at each period of shut-down, depending in amount upon the length of time they have been stopped. Where the cylinders are not covered with a tenacious film of properly compounded steam cylinder oil, the admission of these slugs of water will tend to wash the lubricant from the wearing surfaces, and for the next few strokes insufficient lubrication will be possible and scoring and abnormal wear may occur.

Constant repetition of this will produce compression losses and lead to inefficient operation of the entire machine due to steam leakage past the piston rings. Groaning of the engines or rattling of the valves on their seats will be audible indication of insufficient lubrication.

Point of Lubricant Application

Steam cylinder oils should be introduced into the steamline some six to eight feet above or preceding the throttle valve wherever practicable. This will allow time for atomization to be completed by the time the lubricated steam reaches the throttle valve; this insures lubrication of this element along with the engine valves and cylinders.

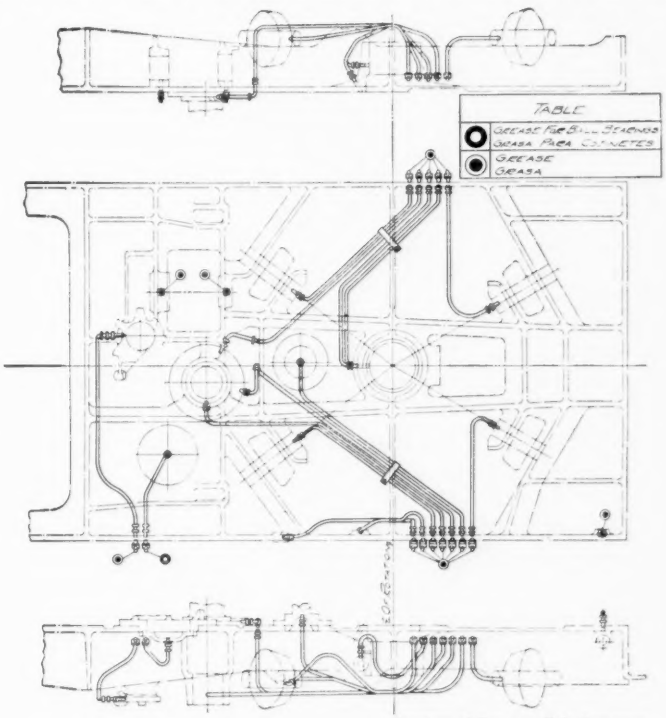
Where oil is introduced too close to the throttle valve or cylinder, complete atomization may not take place; if too far away there will be a possibility of the oil particles being thrown out of the steam and onto the walls of the steam line, to flow subsequently in liquid form to the valve chest. This condensation of lubricant may be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest. It is not conducive to effective lubrication.

Steam cylinder oils should be delivered by a positive feed lubricator, preferably of the force feed type, via suitable atomizers. Hydrostatic lubricators would be practicable were the engines to operate continually, but the usual intermittent service involved would either require constant closing and opening by the fireman, or else a waste of oil would follow if the lubricator were left in service while the engines are stopped.

Location of the crowding engine on the boom in certain types of these machines frequently presents a problem in lubricant application. The oil line often enters the steam pipe at a considerable distance from the throttle, with the result that in event of steam leaks at the ball or swing joint there will be considerable loss of oil with possibility of insufficient lubrication.

Types of Lubricants

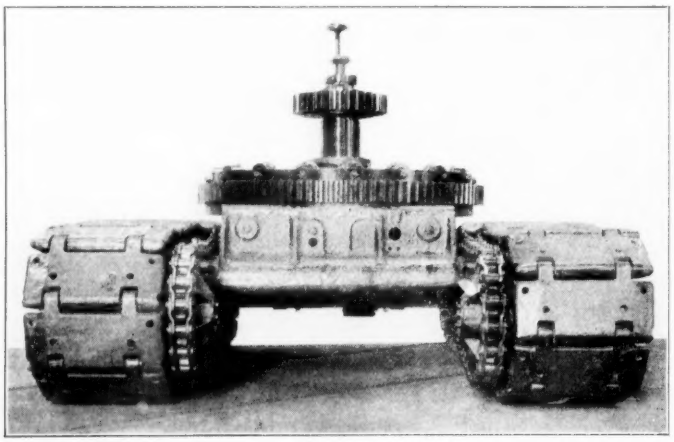
Average requirements can be met most effectively by using steam cylinder oils of comparatively heavy body, and particularly adhesive characteristics in order to insure the maintenance of a lubricating film which will resist the wearing or scraping effects of the average valve and piston, and washing off by the steam itself. This will be assured by using a medium viscosity, highly adhesive, steam refined cylinder stock which contains a sufficient amount of high grade animal or fixed oil to promote the formation of a tenacious film of emulsified lubricant, which will adequately resist the washing action of any water that may be present.



Courtesy of Bucyrus-Erie Company

Fig. 4—Showing manner in which bearings of a revolving frame of the Bucyrus-Erie gasoline excavator are arranged for greasing. Note the location of grease piping and fittings and the ease with which inaccessible parts can be lubricated.

Viscosity or body is attainable by suitable refining; adhesiveness by judicious treatment of the cylinder stock by the addition of certain fixed or fatty animal oils. As a general rule, it will be essential to use an oil having a viscosity range of between approximately 100 and 160 seconds Saybolt at 210 degrees Fahr., according to the steam pressure and temperature involved, the type of steam valves and the means of application. The latter, in turn, requires study of the construction of the atomizer and the type of lubricator.



Courtesy of The Marion Steam Shovel Company

Fig. 5—Showing front view of tractor element of a Marion power shovel. Note in particular the relative location of driving chains to tractor; also main gears.

A suitable atomizer installed in the steam line affords a most efficient way of getting the lubricating oil to all desired points inside of the valve chambers and cylinders by using the steam as a carrier. By thus dividing the oil into minute globules and intimately mixing it with the steam, only a very small quantity is required. The degree of success in atomization of the oil will control both the efficiency of lubrication of the parts and the quantity necessary.

AIR COMPRESSORS

Air compressor cylinder lubrication must be throughly understood in connection with construction machinery, for air is widely used as the motive power for rock drills, concrete breakers, certain types of hoists, riveters, chippers, reamers and certain power shovel mechanisms. The portable compressor is widely used in such service.

The air compressor cylinder requires an oil which possesses certain very definite properties. It must not only lubricate effectively, but at the same time it must also resist decomposition when exposed to heated air; otherwise it might become a hazard, due to possibility of explosion. Those properties which will indicate the ability of the oil to meet the above requirements are covered by the relative change in viscosity, the flash and fire temperatures, and the tendency to form carbon deposits within the compressor.

Relation of Viscosity to Temperature

Viscosity is indicative of relative fluidity. In service, change in relative fluidity will occur with change in temperature, higher temperatures causing oils to become more fluid. Since cylinder wall temperatures will vary, the operating viscosity of the oil must be given careful consideration; the degree of piston seal attainable can be judged by the indicated viscosity of the oil at the operating temperature. This will in turn affect the efficiency of compression.

Where an oil is too light in body or too low in viscosity at the operating temperatures in the cylinder, it might easily work past the piston rings and fail to maintain a suitable seal. In turn, too heavy an oil would tend to develop gummy matter which might cause the piston rings to stick. An air compressor oil should consequently have sufficient viscosity to sustain the weight of the moving parts, and form a proper seal between the piston rings and cylinder walls; on the other hand, it should never be so heavy as to atomize with difficulty or collect any dust that may be present in the air to generate deposits. This is especially likely to happen when more oil has been used than just sufficient to lubricate the wearing surfaces, or where the air is not properly cleaned.

Flash and Fire Points

The degree of importance which should be attached to these properties is questionable. Suffice it to say, they have been decidedly over-emphasized in their relative importance as qualifications for air compressor lubricants. In fact, observation of the conditions under which explosions may tend to occur indicates that the possibility of formation of deposits within the compressor or air lines requires far more consideration. The cause of such deposits has been already mentioned. In any installation where they are present and rendered incandescent for any reason whatsoever, an explosion may occur, irrespective of the flash or fire points of the lubricating oil.

Inasmuch as petroleum oils are composite hydrocarbon mixtures, different portions will be distilled or vaporized at different tempera-

tures. Under such conditions certain of the lighter products may pass off even at temperatures below the flash point, leaving the heavy ends dissolved in the oil next to the wall. Ultimately should an excess of high carbon content oil be used, oxidation and the building up of a gummy mass which has a low vapor pressure and high distillation point, may result. The carbon residue content, as indicated by the Conradson test will enable authorities to predict the probable extent to which the above will occur.

Carbon Deposits—The Result of Oil Breakdown

Deposits of carbon plus dirt on the valves or in the discharge lines of an air compressor, or later on in rock drill or other air tool mechanisms are the direct result of breakdown of lubricating oil. It is impossible to eliminate this, for mineral lubricating oils, regardless of their base or nature, will decompose to volatile products and carbon when subjected to heated air under pressure. On the other hand, the extent of this decomposition will depend upon the length of time the oil is exposed to such heat. Naturally, it will also follow that with oils of the same degree of refinement, the one which remains in the compressor cylinder or on the discharge valves the longest will form the greatest amount of such deposits.

For this reason an oil having a wide range of distillation, high end point, or too great a viscosity is objectionable, inasmuch as, instead of vaporizing cleanly, it may break down and become sticky, collecting dirt brought in by the air. The slower the breaking down process, or the greater the volume of oil, the more carbon will ultimately be developed.

Pale filtered oils, where properly refined, have been found to show the least tendency toward direct carbonization and the development of carbonaceous matter. They are, therefore, generally accepted as best suited to air compressor and pneumatic tool service. It is of interest to note that any such direct carbon as may be formed through excessive use of such oils is normally of a light, fluffy nature. Carbon deposits formed from improperly refined or unsuitable oils, on the other hand, are often of a hard, flinty nature. Any oil, however, will accumulate dust if the air is dirty and no provisions are made for filtration or cleaning, to lead to ultimate formation of deposits.

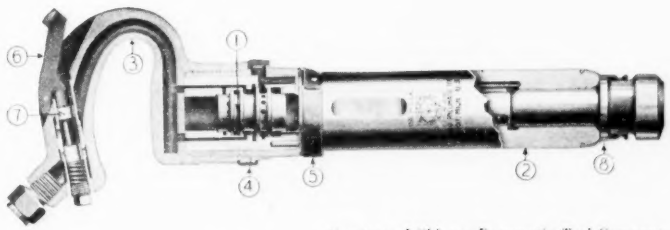
AIR TOOL LUBRICATION

Lubrication of pneumatic tools must be studied with respect to operating conditions. In construction work such equipment is very often subjected to decidedly severe service, due to careless handling and contact with rock, steel, concrete, mud, or water. This will result in more or less ultimate damage to the working mechanisms, even if the casing is rugged enough to come through whole. Furthermore, a certain amount of dust, dirt and water may frequently gain entry to damage, score or abrade the wearing elements.

Service of this nature imposes an equally severe load upon the lubricants used. It is relatively difficult for many lubricants to withstand moisture conditions, however suited they may otherwise be to the actual operating requirements; for water will tend to wash off the lubricating film from wearing surfaces. For this reason compounded lubricants, i.e., mineral oils containing more or less animal oil or soap compound, are recommended for the lubrication of air tools operating under excessive moisture conditions. Such lubricants function on the same principle as do steam cylinder oils. In other words, they have more tendency to adhere to metal in the presence of water than do straight mineral oils, by reason of their ability to form emulsions.

Such lubricants are especially suited to rock drill service wherein water is intentionally mixed with the air to serve the purpose of washing cuttings from the hole, in much the same manner as a soluble oil solution washes metal cuttings away from the tool in certain types of machine shop practice.

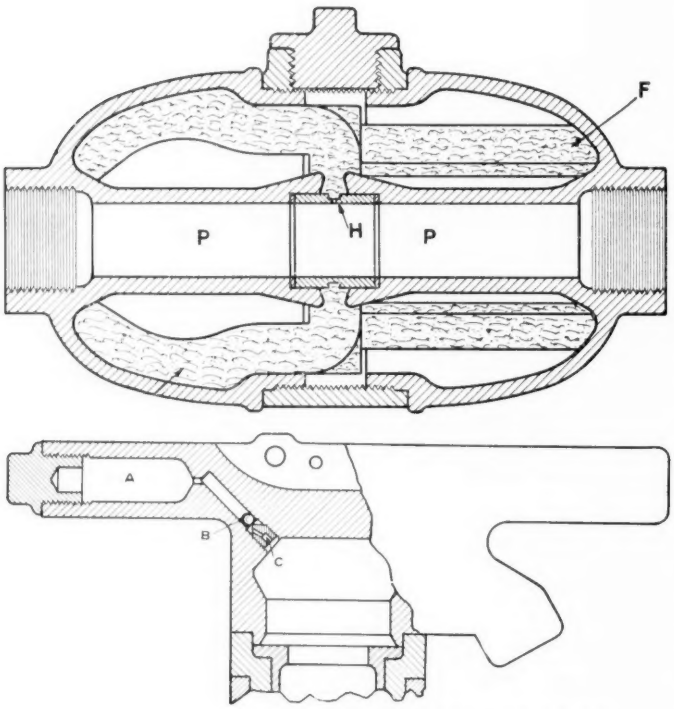
On the other hand, where pneumatic tools are designed to function dry, care should be taken to keep them as free from moisture as possible; for on such equipment straight mineral lubricants are generally used. These should be made from selected crudes, very carefully refined. If they are of the requisite viscosity they will adequately withstand any slight washing effect that may occur from condensation of moisture from compressed air as normally used. They will not, however, protect the wearing surfaces against an excess of moisture should



Courtesy of Chicago Pneumatic Tool Company

Fig. 6—Cutaway view of a Boyer riveting hammer. (1) indicates hollow cylindrical valve; (2) special steel cylinder; (3) handle; (4) locking ring; (5) exhaust deflector; (6) trigger control; (7) throttle valve; (8) Boyer spring clip retainer.

the tool be dropped in the mud or allowed to remain exposed to the elements for any length of time while not in use. This would, or course, lead to rusting and corrosion, with subsequent difficulty in operation, and the necessity for repair or parts replacement.



Courtesy of The Cleveland Rock Drill Company

Fig. 7—Top view shows a Cleveland type of line oiler. (F) indicates felt wicking, which serves to draw oil from the lubricating chamber by capillary action. This oil accumulates at regulating hole (H) being carried by flow of air through central passage (P) to lubricate the tool. Lower figure shows oiler for paving breaker. This is a regulator type of lubricator, oil passing from chamber (A) via ball (B) through port (C) and thence to mechanisms.

Careless handling will also lead to entry of abrasives such as dust and dirt. We must also consider the dirt which may be carried through the tool by the air itself in case there is no air filter installation. Any abrasive material will cause wear. It is easier to protect a tool against entry of abrasive foreign matter via the tool itself than via the airline. Rarely will any appreciable amount of dirt penetrate the tip orifice while air is passing through it. All that is usually necessary is care in handling when not in actual operation. So when inactive it should be stored or rested in a position or locality free from dirt.

Clean air, however, is not always possible to obtain. This will all depend upon the location of the compressor, its air intakes, whether or not air filters are installed, and the cleanliness of the air coolers and air lines. Furthermore, there will also be the possibility of particles of rust being carried along by the air, especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture. Particles of rubber from the air hose and gaskets may also find their way into the air passages and cylinders along with other foreign matter, to interfere with the free operation of the tool. Fortunately, a wire strainer of suitable fineness located in the inlet pipe has been found to be advantageous in the removing of much of this foreign matter.

Methods of Lubrication

It is also important to protect some types of pneumatic tools against the entry of foreign matter at the time of lubrication. Where automatic lubrication is provided for by means of pipe line lubricators or atomizers which mechanically deliver the requisite amount of oil to the air lines, there will be the least possible chance of dust or dirt being carried in, provided that the oil is properly stored and handled. These devices literally lubricate the air, as already mentioned, in much the same manner as mechanical or hydrostatic lubricators will lubricate the steam in a steam engine. Air under pressure, just like steam, will readily carry and distribute properly atomized oil to all the working elements of the tool.

Hand lubrication of drills, hammers and other such tools, in the absence of automatic means of lubrication, must often be expected to involve possibility of accidental entry of dust or dirt. Operators' hands will be dirty, and around industrial plants the atmosphere will often be laden with dust. Of course, under such conditions the lubricants for current usage should be stored and handled with the utmost care, and yet in the interest of eliminating loss of time, lubricants will often be kept in open cans adjacent to the tools. Naturally, considerable dust and dirt may settle in these containers, the tools being subsequently lubricated with a mixture so abrasive as frequently to cause them to wear entirely too rapidly.

Experience has proved the necessity for three distinct varieties of lubricants to meet the operating and constructional conditions encountered in pneumatic tool service. These include:

1. Compounded lubricants for tool mechanisms wherein water is employed.
2. Products with a low pour test oil as the base where cold weather operation prevails, and

3. Specially prepared greases for heavy slow moving tools or parts which will function best on such products.

Structural Requirements

The valve and cylinder mechanisms of higher speed tools, as well as some other parts are designed for oil lubrication. Where tools involve gearing the matter of lubrication requires that gears, crankshaft bearings and cylinders must also be served. In many tools this requires two lubricants; one of the nature of a liquid grease to serve the gears and crankcase bearings, etc., the other an oil to serve the cylinders.

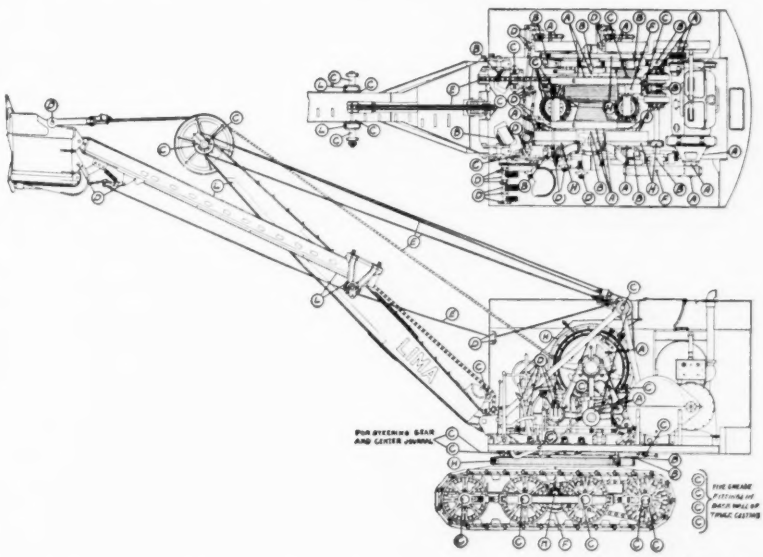
Another problem has developed due to use of anti-friction bearings. In the more modern type of air drill for example, the crankshaft will frequently be equipped with ball bearings, the connecting rod being furnished either with plain or roller bearings. It is, of course, essential that the crankcase lubricant be such as to lubricate these varied bearings adequately with the least amount of internal friction and tendency to separate or to develop free fatty acids.

Air cylinder lubrication will also frequently involve the problem of possible low temperatures. In rock drills, especially, will there be possibility of abnormally low temperatures, due not only to the moisture content of the air, but also the fact that narrow, tortuous air passages must generally be traversed in the course of expansion. In such drills it is frequently customary to "lubricate the air" prior to its delivery to the tool by means of a suitable lubricating device installed in the air line a short distance back from the throttle valve.

Methods of Handling Lubricants

In conjunction with the type and extent of refinement of the lubricants employed, the means whereby they are admitted or distributed has a marked effect upon their ability to insure efficient and economical tool operation. Obviously even the best of lubricants may function ineffectively if they are unable to reach all the wearing parts of the tools. Probably more failures and complaints arise from ineffectual lubrication through misusage of lubricants than from any average operating condition. In many cases they can be traced to ignorance; in others, lack of appreciation of the lubricating requirements on the part of the operators. With an understanding of these latter, and knowledge of the lubricants which are available in most cases refined more or less especially to serve pneumatic tools, with a minimum of fluid friction, a maximum of sealing ability in the prevention of air blow-by past the piston, and an ability to flow commensurate with the operating requirements, operation of pneumatic tools in construction work should be materially simplified.

The operator, however, must study his own particular operating conditions, selecting and using his lubricants intelligently, in accordance with the recommendations of the builders of his tools, and the oil company from whom he purchases. Makeshift or obsolete ideas may have been permissible in the past; today, the necessity for maximum production demands the adoption of the most modern means of lubrication, in the interests of continued and efficient operation. For this reason builders of pneumatic tools have given much attention to the development of automatic lubricators, which can be built as an integral part of the tool valve chest or installed directly in the air line, a short distance back from the tool.



Courtesy of The Ohio Power Shovel Company

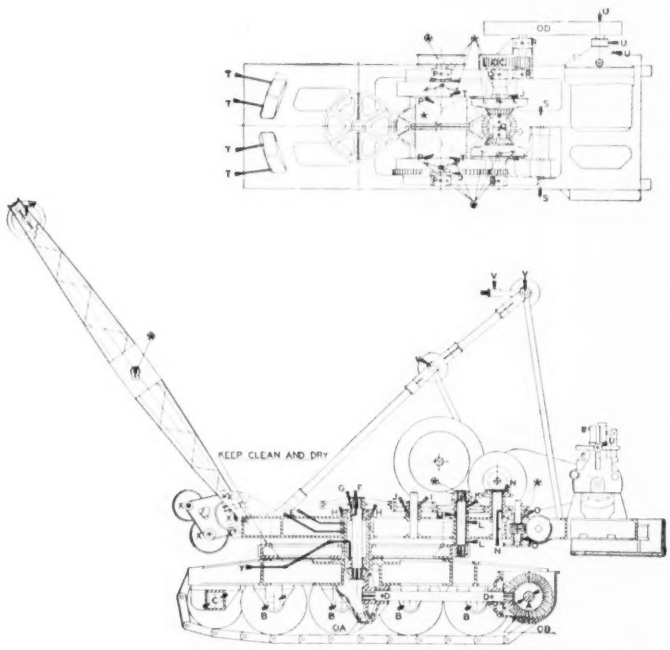
Fig. 8—Sectional and plan views of a Lima power shovel. (A) indicates points where soft grease should be used every 10 hours (B) where similar lubricant should be used every 20 hours (C) every 4-5 hours. At points D and E a good grade of machine oil should be used, at (F) transmission lubricant is required; at (H) a good grade of heavy gear lubricant, applied hot every four hours. At (J) soft grease should be renewed every 90 days. (L) calls for a good grade of steam cylinder oil and (M) a light lubricating or penetrating oil.

The Valve Chest Lubricator

This device operates by virtue of the pulsations of air in accordance with the movement of the piston within the cylinder of the tool. As a

rule such a lubricator is designed for the usage of heavier oils or liquid greases. Re-lubrication or re-charging is brought about by the use of lubricant-carrying cartridges, through suitable plugs.

Chuck lubrication is also mechanically effected on many types of tools, a suitable device being attached near the front end adjacent to the chuck parts. In certain types of such lubricators ports are provided for carrying the lubricant to the impact end of the piston and chuck mechanisms. Medium bodied grease has been found to be adaptable to the average operating condition to which such parts will be subjected, although compounded oils are also suitable.



Courtesy of Link-Belt Company

Fig. 9—Lubricating diagram for a Link-Belt Crawler, adaptable to shovel, crane or dragline operations. Parts A to X inclusive are designed for grease lubrication. Parts OA and OB require a heavy bodied lubricating oil. Parts OC and OD are spur gears and silent chains, requiring crankcase oil. Star indicates points designed for oil lubrication.

Air Line Oilers

In contrast with the above, the average air line oiler is in general intended for the handling of fluid oils, and lubrication of air prior to its passage to the tool. As a rule such devices work on the principle of atomization, pulsation, or suction action. Where suction is involved the air, in its passage through the working mechanisms, draws the requisite amount of oil from the reservoir by suction. In the atomization lubricator, there is a needle or pin valve through which a certain amount of air passes to carry the required lubricant forward into the tool. In both types, the air as it passes through the lubricator becomes charged with oil in finely atomized condition, to insure effective distribution to all parts of the tool with which it may come in contact. Operation of the pulsation type of oiler is brought about by the reciprocating action of the piston keeping the oil in continuous flow to the air and tool mechanisms. Such a lubricator is frequently built with an oil capacity sufficient to last over a working shift. This materially reduces the possibility of lack of lubrication through negligence or carelessness on the part of drill or tool operators.

WIRE ROPE

By reason of the extent to which wire rope is employed in the operation of construction machinery, it will be advisable to discuss the essentials of wire rope lubrication in considerable detail. It must be remembered that however efficiently the power plant may be operating, the ultimate degree to which the machine as a whole will perform its intended function will depend upon the condition of the cables and wire ropes.

In other words, should a rope have one or two broken strands, due to insufficient or improper lubrication, it might very easily lead to a tie-up of the machine should the ends of the strands interfere with the operation of the sheaves. This might also involve a distinct hazard, for any wire rope in such condition is weak and more or less incapable of handling the loads to which it is subjected.

It is not enough to assume that because wire ropes come from the manufacturers in a lubricated state, being in general wound on an oil-saturated core, that further lubrication is unnecessary.

Under operation there is constant friction and wear between the strands, and a tendency to squeeze out any contained lubricant, especially when the rope passes over sheaves or around drums. The renewal of this product, therefore, is an absolute necessity.

The matter of friction between the strands of a wire rope is essentially the same as friction between a bearing and a shaft. Overheating and abnormal wear will practically always result, to reduce the load-carrying capacity and increase the amount of power consumed in operation. This can only be overcome by effective lubrication, brought about by the proper application of a suitably prepared wire rope compound which will be capable of not only penetrating to the innermost strands and

core of the rope, but also sufficiently adhesive and viscous to resist being prematurely squeezed out or washed off by rain or sleet.

Lubricant Characteristics

A wire rope lubricant, in addition to having the properties mentioned above, must not tend to cake, gum, or ball up, especially if contaminated with an excess of dust, dirt or metallic particles. Furthermore, it must resist the thinning-down effects of higher temperature. This, of course, directly involves the viscosity or relative fluidity of the product. In fact, viscosity in such a product is the essential characteristic involved in purchasing. It should not be assumed, however, as being the chief guide in regard to the actual suitability of a wire rope lubricant. The ability of the latter to function, penetrate and stick under actual operating conditions, is of more outstanding importance. In consequence such products should not be purchased haphazardly, nor on a price basis alone. The potential difficulties that might result in cold weather are too serious.

According to the operating temperatures that may be involved, and the possibility of the presence of an excess of water, the viscosity of a wire rope lubricant should range from 500 to 1000 seconds Saybolt at 210 degrees Fahr. Where there might be possibility of such a product thinning down to the extent of dripping off to perhaps result in lack of lubrication, it will be advisable to use a lubricant of approximately 1000 seconds viscosity, of course, in accordance with the prevailing temperature. Under relatively cold conditions, it might be advisable to use a thinner product, but again in accordance with the range of operating temperatures involved.

Wire rope lubricants should, in general, be straight mineral petroleum products, free from fillers or thickening mediums. In other words, whatever the viscosity, it should be an inherent property of the lubricant, not an artificial characteristic which cannot be depended upon.

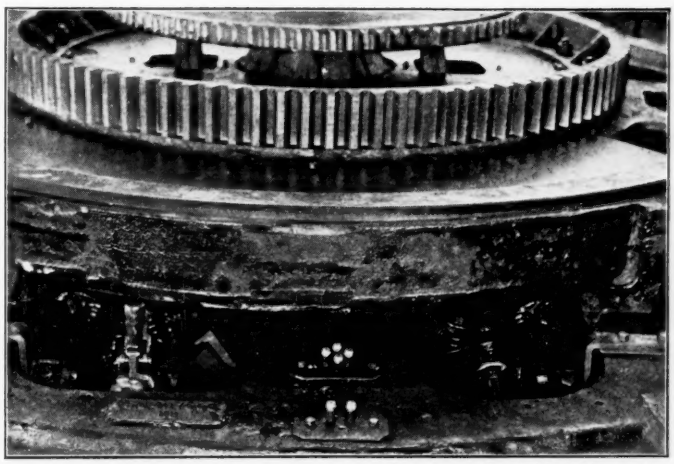
As a general rule, such products, by virtue of their viscosity, must be applied in heated condition. To merely attempt to daub or paint a rope with such a product at normal temperatures would be relatively ineffectual. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote.

We must realize that this latter is the secret of effective wire rope lubrication. The amount of wear occurring between the exterior of such a rope and the sheaves is not as marked as that which occurs between adjacent strands when the rope is flexed or bent, as in passing over sheaves or hoisting drums. On the other hand, bending promotes penetration of the lubricant.

TRANSMISSION AND REDUCTION GEARS

There is a considerable problem involved in the lubrication of power transmission and speed reduction gears on certain types of power shovels and excavating machines, due to the fact that they are usually exposed, or inadequately housed. There is, therefore, every possibility of dust and dirt gaining entry, to increase the amount of wear and alter the pitch line. Pressure also requires consideration in such gear installations. As a general rule pressure will be comparatively high, due to the small areas of contact. The more accurately the gears have been cut the more intense will be the unit pressure, inasmuch as line contact will more nearly prevail.

Gear tooth pressures change constantly as opposing teeth mesh with each other. This causes change in the direction of application of the load. As long as rolling motion predominates, however, the effect on the structure of the teeth will not be serious. When wear occurs, however, there will be a tendency for the motion between the teeth to become sliding instead of rolling. This will give rise to a certain amount of grinding between the teeth, and bring about wear, especially if lubrication is not maintained in an effective manner.



Courtesy of Harnischfeger Corporation

Fig. 10—Showing installation of centralized lubrication attachments for carrying lubricant to horizontal propel shaft bearings, corduroy drive shaft bearings, and clutch throwout lever shaft bearings.

It is therefore essential that a gear lubricant possess sufficient oiliness to reduce friction to a minimum. This characteristic is dependent

upon the viscosity and the ability of the lubricant to adhere to the teeth and resist the prevailing pressure.

Temperature will also affect this property, although in the normal operation of excavating machinery, gears will function at atmospheric temperature. As a result, there will be but little possibility of the gear lubricant being reduced in viscosity by abnormal heat.

The effect which low temperature may have upon a gear lubricant in service requires more consideration. Certain grades of lubricants will have a tendency to congeal to such an extent as to become brittle and crack. If a lubricant has been properly refined, however, there should be little danger of this occurring. Straight mineral lubricants will generally be best adapted to the prevailing operating conditions. The average range in viscosity for service on exposed gears will vary from approximately 1000 to 2000 seconds Saybolt at 210 degrees Fahr., the lubricant being chosen to meet the operating temperatures and size of gears.

Where gears are enclosed, as is the practice in connection with transmission units or certain types of friction drive machines, the use of chain drives in certain of these installations will require a more fluid lubricant. It must be borne in mind that the average silent chain drive, as employed in this service will involve comparatively low clearances between the connecting elements which go to make up the links. It is important, of course, that the lubricant be capable of penetrating to all surfaces of contact between these parts; otherwise, abnormal wear will take place. A lubricant of about the same viscosity as a heavy steam cylinder oil, i.e., in the neighborhood of 150 to 200 seconds Saybolt at 210 degrees Fahr., has proved satisfactory for such service.

Indication of Wear

Noise is the primary indicator of wear in gears and driving chains. As a general rule, there will be considerably more possibility for ventilation than prevails with the average bearing. In consequence, increase in operating temperatures will usually not be as marked, even in extreme cases of faulty lubrication of gear teeth or chain link connections, for radiation will serve as an effective means of temperature reduction.

Furthermore, whereas, it is often practicable to test the temperature of a bearing by hand, with a gear or chain, this practice would be hazardous, and even if possible would be no indication of the probable actual temperature at the wearing surfaces.

Development of noisy, clanking operation, however, is a decidedly positive indication that a gear or chain lubricant is not functioning as it should, in the prevention of metallic contact and solid friction.

It will be of interest to note that with gears especially there will be periods over which the lubricant will be inactive, for actual friction between the teeth will only occur when they are in mesh. To a somewhat less extent the load imposed upon a chain link connection will also be decreased over the period of slack operation.

Chain lubrication, on the whole, is akin to bearing lubrication in the requirements which will be imposed upon the lubricants. There is, however, more chance for lubricant to be thrown off from a chain link than from the average bearing, for even though bearings may be themselves subject to rotary or reciprocating motion, this will not be as severe as the action of centrifugal force involved in a chain installation. The effect of centrifugal force must be especially considered in the lubrication of exposed or semi-enclosed chains. Centrifugal force will be greatest during the period of bending, as the chains pass over the sprockets. At such times any lubricant on the outside surface of a chain may be thrown off, although this will depend upon the adhesive ability of the lubricant and the peripheral or surface speed of the sprockets.

There are two primary steps which must normally be followed in the safeguarding of driving chain lubrication, viz.:

1. The selection of a lubricant of adequate viscosity and adhesive ability, commensurate with the manner of housing and the method of application, and

2. Application of this lubricant over the inner or more active wearing surface, in order to insure as complete penetration as possible to the link connections before the lubricant has a chance to work its way to the outside surface of the chain from which it may be thrown off.

Of course, these points will apply more strictly to the exposed or semi-enclosed chain drive, wherein there is but little or no provision for automatic lubrication. Where a driving chain is subject to a constant supply of lubricant as in the timing gear drive in some automotive engines, or those enclosed industrial chains which are fitted with oil pumps and suitable piping for circulation of oil from a base reservoir, maintenance of lubrication is normally positive, and only requiring of an adequate supply of properly refined lubricant.

A carefully designed housing is a most important feature in the safeguarding of lubrication of any chain, for it enables the lubricant to function most effectively.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
72 Washington St., N. Y. C.